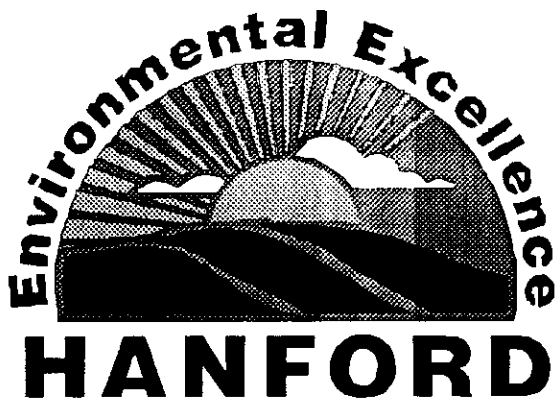


STAR

0028106



**Regulatory Support
Department**

RCRA Permits Section

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington, 99352

Date: November 17, 1992

To: Dan Duncan

Fax: (206) 553-0957

Location: EPA, Seattle

Phone: (206) 553-6693

From: S. J. Skurla

Phone: (509) 376-7957

MSIN: H4-57

FAX: (509) 376-6476

Verify: (509) 376-7775

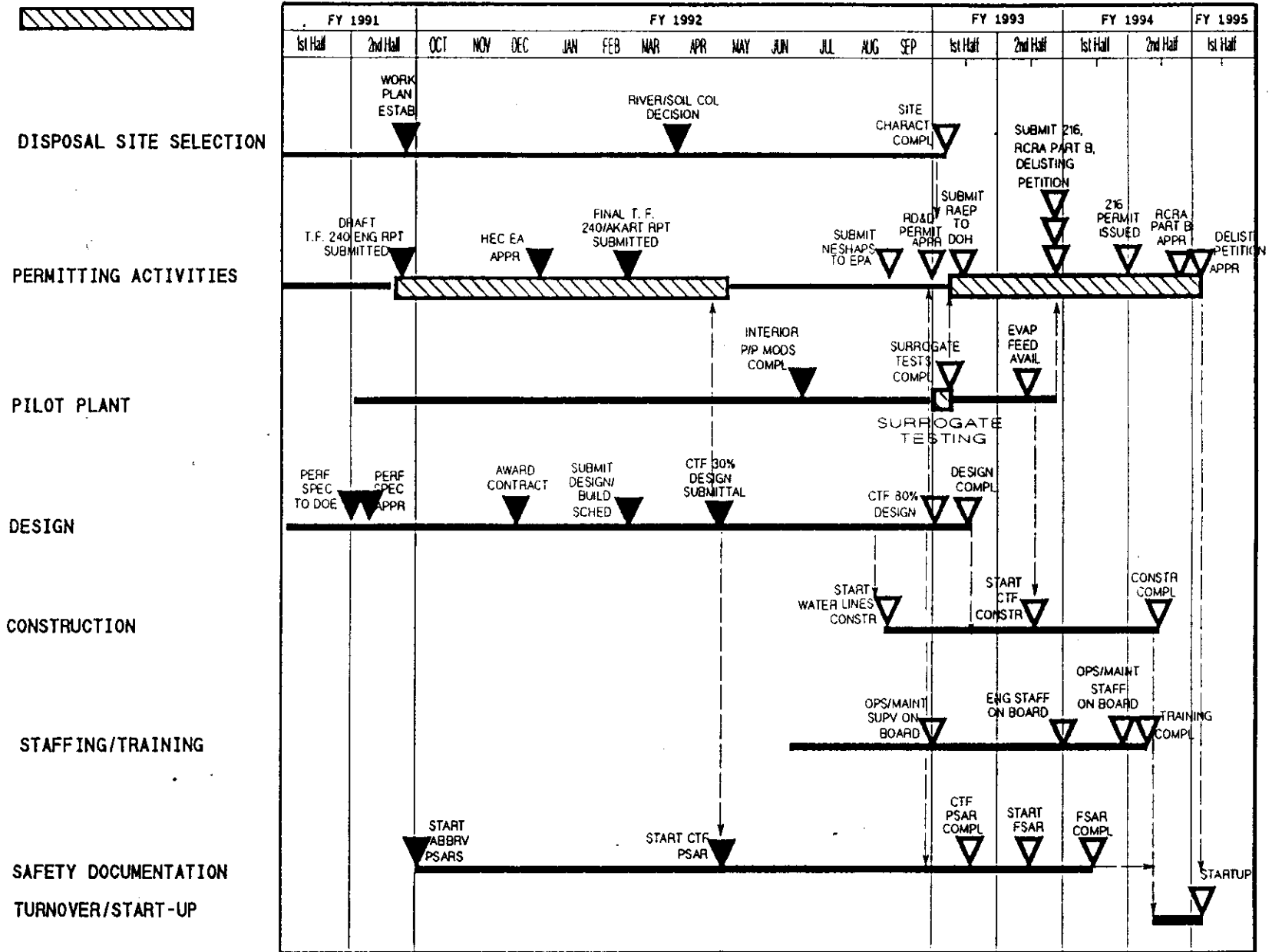
This Fax consists of 22 pages including cover sheet.

Message: Attached are additional draft page changes for your information.
I don't think these changes should present any problems.



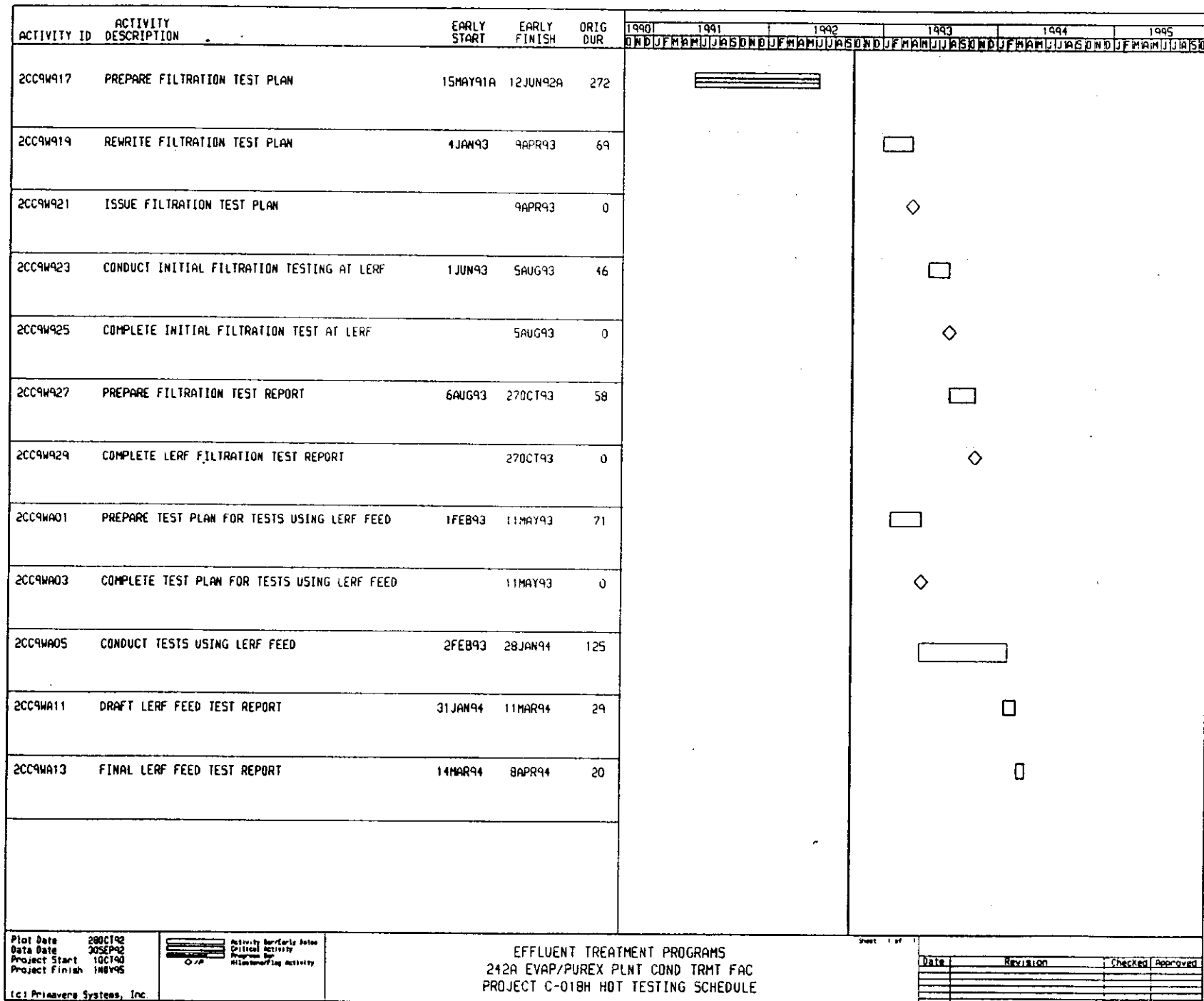
Figure 2-1. 242-A Evaporator/PUREX Condensate Treatment Facility Summary Schedule.

Critical Path



9 3 1 2 9 3 6 0 6 1 6

Figure 2-2. Tentative Waste Water Pilot Plant Testing Summary.



1 to believe that these chemicals would be present in the waste stream planned
2 for testing in the waste water pilot plant.

3
4 Several organic chemicals and inorganic elements on Appendix VIII
5 (40 CFR 261) with the designation "not otherwise specified" (N.O.S.) were
6 eliminated. This designation is used to describe generic classes of inorganic
7 compounds (e.g., lead compounds N.O.S.) or organic compounds (e.g.,
8 chlorinated benzenes, N.O.S.). Organic chemicals designated as N.O.S. can be
9 legitimately eliminated from the comprehensive list because the specific
10 isomers of concern within the group (such as o- or m-dichlorobenzene) already
11 are individually listed on the comprehensive list. Inorganic chemicals
12 designated N.O.S. can be eliminated because the parent metal (such as lead) or
13 the individual compound (such as lead acetate) also is included on the list.

14
15 Some inorganic salts on the Appendix VIII list (40 CFR 261) were deleted
16 because the metallic cations are already on the comprehensive list of
17 chemicals of concern. These chemicals are included in the analysis for the
18 parent metal and deletion will not result in the loss of significant
19 information.

20
21 Some nonpriority pollutant pesticides and herbicides were removed from
22 the comprehensive list. The basis for this is that no pesticides or
23 herbicides have been identified in either the Hanford Site inventory document
24 (WHC 1990) or in any of the historical data for waste water streams.

25 26 27 3.3 OPERATING ENVELOPE

28
29 The purpose of the operating envelope is to preclude waste water pilot
30 plant conditions that would be potentially unsafe to human health and the
31 environment. The operating envelope includes three components. The first
32 component addresses the composition of the waste water received in the waste
33 water pilot plant. The second component addresses the composition of the
34 waste water after modification by chemical spikes. The third component
35 addresses the operating parameters that are in place to ensure that the
36 equipment in the waste water pilot plant will be operated within limits that
37 protect human health and the environment.

38 39 40 3.3.1 Waste Water Acceptance Criteria

41
42 The composition of the waste feed to the waste water pilot plant has been
43 characterized by analyses of 34 samples and other process control samples of
44 242-A Evaporator process condensate collected over a period of almost 4 years
45 (Table 3-1). Some variability is expected in waste composition, thus a
46 sampling program will be implemented to ensure that the waste composition will
47 be within the operational capabilities of the waste water pilot plant.

48
49 The waste acceptance limits for the waste transferred to the waste water
50 pilot plant is shown in Table 3-3. The metals include all the toxic metals
51 reasonably anticipated in the 242-A Evaporator process condensate.
52

- Differential pressure
- Low vessel vent vacuum.

The critical parameters are discussed in detail in Section 4.0. The critical parameters, their limitations, and how the parameters are monitored and controlled are shown in Section 4.0, Table 4-4.

3.4 WASTE ANALYSIS PLAN

The waste analysis plan will provide data to establish that the 242-A Evaporator process condensate transported from the LERF is within the waste acceptance limits for pH, ammonia, toxic metals, and volatile organic compounds. This will be accomplished through sampling and analysis of the process condensate before unloading at the 1706-KE Building.

The waste analysis program is based on the following considerations.

- The toxicity of the waste is low.
- After pilot plant testing, the waste will be transferred to the LERF for storage until treatment at the 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility.
- The potential release of volatile organics to the atmosphere will be controlled at the 1706-KE Building by the use of two stages of carbon adsorbers, in series. The use of an interstage organic vapor analyzer provides continuous on-line monitoring with alarm to indicate 'breakthrough' (saturation, or full loading) of the first stage adsorber.

The concentrations of the constituents added during spiking will be controlled through the use of test plans and test procedures and to not exceed the levels shown in Table 3-4.

3.4.1 Sampling and Preservation

To determine if the waste is within the waste acceptance limits, a composite sample of the LERF waste water will be collected during the filling of the tank trailer. This will be accomplished using a sample port on the tank trailer fill line.

Samples will be collected and preserved in accordance with Table 4.1 of the QAPP (Appendix 2A).

3.4.2 Analyses and Analytical Methods

The waste water samples collected during the filling of the tank trailer at the LERF will be analyzed for pH, ammonia, metals, and volatile organic compounds. The analytical methods to be used are listed in Table 3-3. The

1 breakthrough is detected, the primary charcoal unit will be removed and the
2 secondary unit would become the primary unit. A fresh unit then would be
3 installed as the secondary unit. Breakthrough of the first stage charcoal
4 adsorber will be considered to be at 10 parts per million as shown on the
5 organic vapor analyzer. The analyzer will be set to alarm at that point.
6 Operations will be stopped within 72 hours of the alarm, and the adsorber
7 changed out. Immediate shutdown is not necessary because of the redundant
8 emission control provided by the second stage charcoal adsorber.
9 Manufacturer's information on the organic vapor analyzer is presented in
10 Appendix 4C.

11
12 **4.1.3.3 Emission Monitoring Equipment.** Stack effluent radionuclide content
13 will be monitored with a particulate record sampler. These sampling systems
14 remove a sample from the stack and pass the sample through a 1.9 inch
15 (47 millimeter) filter. The sample flowrates are controlled by a rotameter,
16 which is calibrated routinely. The record sampler filter will be collected
17 monthly and analyzed for total alpha and beta/gamma activity.

18
19 The organic vapor analyzer is used to determine breakthrough of the first
20 stage charcoal adsorber as described in Section 4.1.3.2. Because a redundant,
21 second stage charcoal adsorber is located downstream of the analyzer, this
22 analyzer does not directly monitor organic emissions to the environment. The
23 organic vapor analyzer is a photoionization detector (PID) operating at a
24 continuous sample flow rate of 0.1 cubic feet (3 liters) per minute. The
25 operating range will be set at 0 to 100 parts per million with a resolution of
26 0.1 part per million. Because the analyzer is being used to determine the
27 changeout of the first stage charcoal, and not to quantify emissions, a two
28 point calibration will be accomplished utilizing zero and span calibration
29 gases. The span gas will be 5 to 30 parts per million (5 to 30 percent of
30 scale) of a volatile organic most representative of the vapors expected in the
31 ventilation system and commercially available.

32 33 34 **4.1.4 Waste Water Pilot Plant Capacity**

35
36 The throughput of any operation at the waste water pilot plant will be
37 nominally 5 gallons (19 liters) per minute which is the equivalent to
38 300 gallons (1,100 liters) per hour. The ultraviolet oxidation unit will
39 operate at flow rates as high as 25 gallons (95 liters) per minute in the
40 recycle mode, but have a 5 gallon (19 liters) per minute throughput. The
41 1706-KE process diagram is shown in Figure 4-2 and Appendix 4A. The waste
42 water pilot plant can be operated with a maximum of 5,000 gallons
43 (19,000 liters) per batch. This limit is based on the size of the tank
44 trailer [5,000 gallons (19,000 liters)]. The test program will be structured
45 to accommodate up to one 5,000 gallon (19,000 liter) batch per week [20,000
46 gallons (76,000 liters) per month]. A process rate of one tank trailer every
47 two weeks is anticipated during normal operations. Storage capacity at the
48 waste water pilot plant will include two 5,000 gallons (19,000 liter) tank
49 trailers and two 3,000 gallon (11,000 liter) intermediate storage tanks for a
50 total of 16,000 gallons (61,000 liters) of potentially available storage.
51 Filtration equipment at LERF will be sized at 5 gallons (19 liters) per minute
52 [300 gallons (1,100 liters) per hour] or less for each of the three units,

1 for a total of 15 gallons (57 liters) per minute. There will be no storage
2 capacity associated with the LERF equipment.

3
4 The amounts of waste tested at the waste water pilot plant will exceed
5 limits contained in the guidance document for research, development, and
6 demonstration permits (EPA 1986a). The guidance document specifies limits of
7 400 kilograms (100 gallons) per hour through-put, 15,000 kilograms
8 (4,000 gallons) per month for treatment, and 15,000 kilograms (4,000 gallons)
9 for storage. The conversion of kilograms to gallons was made using factors of
10 2.2 pounds per kilogram and 8.34 pounds per gallon of waste.

11
12 The guidance limits for throughput (EPA 1986a) must be exceeded because
13 5 gallons (19 liters) per minute is the smallest process units that are
14 commercially available. The flowsheet for the waste water pilot plant was
15 developed around this 5 gallon (19 liters) per minute limit. The totals given
16 for the amount of waste tested per month and the storage capacities are
17 maximum values; actual operations are likely to be less. Normal operations at
18 the waste water pilot plant will require storage of 5,000 gallons
19 (19,000 liters) of waste.

20 21 22 4.1.5 Technologies to be Tested

23
24 The types of technologies that will be tested in the waste water pilot
25 plant include the following:

- 26 • pH adjustment
- 27
- 28 • Organic removal (e.g., ultraviolet light mediated oxidation and
- 29 granular activated carbon)
- 30
- 31 • Inorganic removal (e.g., reverse osmosis and ion exchange)
- 32
- 33 • Suspended solids removal (e.g., filtration).
- 34

35
36 Each of the technology types are summarized in the following sections.
37 A general description of the technology, a description of the equipment to be
38 used in testing, identification of the critical parameters of each technology,
39 and a description of the safety features of each type of equipment are
40 presented.

41
42 A summary of the critical parameters of each technology that will be part
43 of the waste water pilot plant is presented in Table 4-4. Also presented is a
44 more detailed description of the critical parameters and how the parameters
45 affect the operation and safety of the equipment. The instrumentation
46 typically used to monitor these critical parameters is specified in Table 4-4.

47
48 The control setpoints on Table 4-4 that activate feed pump shutdown will
49 be verified by operations contractor quality assurance personnel before
50 initial startup of the waste water pilot plant. The assessment will determine
51 if the setpoints are set at, above, or below the level that will result in the
52 hazard described in Table 4-4. The setpoints will be modified if the

}

equipment is not found to be activated before the occurrence of a hazard. The EPA and Ecology will be notified in writing of the change in the setpoints on Table 4-4. These changes will not be considered modifications to the permit application.

The following discussion has been organized under treatment technologies. Where specific equipment has been identified for that technology, a discussion of that equipment is included. Generally, equipment to be used for testing will be supplied by vendors as off-the-shelf stock items.

4.1.5.1 pH Adjustment. A pH adjustment step is required to change the waste water chemistry to enhance the removal or recovery of desired contaminants by downstream process equipment, or to adjust the waste water pH to meet regulatory discharge limits.

The pH of the waste at both the 1706-KE Building and the LERF will be adjusted before treatment. The pH adjustment step is straight forward where an acid is metered into the waste water and thoroughly mixed. The pH adjustment equipment consists of instrumentation and hardware to decrease the process stream pH. This is accomplished in makeup vessels containing two well-agitated compartments.

4.1.5.1.1 Equipment Description. The feed material for the waste water pilot plant will be in the pH range of 7 to 11 requiring an automatic system for adding an acid in the precise amount to change the solution pH to a range of 5.0 to 6.5. This will be accomplished at the 1706-KE Building by metering 95 percent sulfuric acid into the feed stream, followed by a 115 gallon (435 liter) mixing vessel. The pH adjustment equipment is shown in Figure 4-2. As a result of adjusting the pH of the waste to 5 to 6.5 for process optimization, the waste will be compatible with all waste water pilot plant equipment and will not pose a threat to personnel due to corrosivity.

The mixing vessel used at the 1706-KE Building consists of two chambers separated by baffle plates to assure the maximum retention time of 20 minutes. The mixing vessel will contain 115 gallons (435 liters) of liquid, but has a total volume of 137 gallon (519 liters). The mixing vessel will be made of reinforced, 16-gage 304-L stainless steel with internal baffle plates that divides the vessel into two chambers, each yielding 10 minute resident times at a throughput of 5 gallons (19 liters) per minute. Each chamber will contain an agitator and pH analyzer. The pH analyzer in the first chamber will be used to control the acid flow.

The sulfuric acid will be fed from a 30 gallon (114 liter) tank, with two check valves on the feed line to assure that the water can not leak back into the acid feed tank. The average flow rate of acid will be 0.5 ounces (16 milliliters) per minute for the 5 gallon (19 liter) per minute waste water pilot plant feed.

The mixing vessel for the pH system used at the LERF will be of the same construction, except for size. The vessel at the LERF has a total volume of 374 gallons (1,416 liters) and will normally hold 300 gallons (1,136 liters). The extra volume is required to maintain the retention time necessary for

4.3.3.2 Waste Load/Unload Station at the LERF. Tank trailer loading and unloading operations will take place at the LERF load/unload station. The load/unload station will be located adjacent to the existing catch basin for LERF Basin 43. The load/unload station will utilize the catch basin and utilities wherever possible. Secondary containment will be provided as specified in WAC 173-303-630 and 640. The following sections describe tank trailer loading and unloading at the LERF.

4.3.3.2.1 Waste Loading at the LERF. The waste water will be transferred out of the LERF basin 43 using a submersible pump lowered down one of the existing emergency pumpout risers. The emergency pumpout riser terminates in the LERF catch basin (Figure 4-20). The discharge line from the pumpout riser will quick-connect to an all welded load/unload line that will run from the LERF catch basin along an overhead piping support structure (Figure 4-21). The support structure will be located over the position where the tank trailer will be spotted for both loading and unloading. At the outer end of this structure, the line will terminate in a flex hose. The terminal end of this flex hose will quick-connect to the load/unload port on the tank trailer. The on/off controls for the pump will be located at the load/unload station.

The tank trailer ventilation system at LERF will use a 35-gallon drum carbon adsorber (Tigg Model N50 or equivalent) to control volatile organic emissions to the environment during loading (Figure 4-21). A flexible hose with a quick connector at the terminal end will be used to make the connection to the tank trailer vent port. The flexible hose will be connected to a pipeline supported by the overhead piping support structure. The pipeline will run to a 35-gallon drum carbon adsorber located over the LERF catch basin. The adsorber will vent to atmosphere. This ventilation line configuration will be the same for both loading and unloading of the tank trailer at LERF.

Gaseous discharge from the 35-gallon drum carbon adsorber will be monitored during trailer loading and unloading using a portable volatile organic analyzer (HNU* Model PI-101 or equivalent). Vendor information on the HNU Model PI-101 is included in Appendix 4C. An analysis is included in Appendix 4F that shows the concentration of volatile organic compounds to the carbon adsorber during filling of the tank trailer will be a maximum of 40 parts per million. The volatile organic concentration in the effluent air from the carbon adsorber before breakthrough will be virtually zero. When breakthrough is reached, the volatile organic concentration in the waste water will rise fairly rapidly to the inlet concentration. Although the detection limit of the HNU analyzer is reported as 0.2 parts per million, it is necessary to set the breakthrough level sufficiently above the instrument detection limit to eliminate false indications of breakthrough. On this basis, an ascending level that exceeds the value of 10 parts per million will be considered an indication of breakthrough. The time-weighted average (TWA) values for an 8-hour worker exposure limit are 250 parts per million for

50 *HNU is a trademark of HNU Systems Incorporated.

acetone, and 50 parts per million for 1-butanol (NIOSH 1985). If breakthrough of the adsorber is detected, the filling operation will be shutdown and the carbon adsorber replaced.

Bottled nitrogen gas maintained at the LERF catch basin will be supplied to the tank trailer for use in liquid-level indicator. The nitrogen line will be run up and over the tank trailer using the piping support structure described above (Figure 4-21). A terminal end flexible hose with quick-connect fitting will make the final connection to the tank trailer bubble pipe (liquid-level detector) port. This same line configuration will be used for both tank trailer loading and unloading. The liquid-level indicator output will be located at the load/unload station.

4.3.3.2.2 Waste Unloading at the Liquid Effluent Retention Facility.

For unloading, the tank trailer will be spotted at the same location as during loading. The ventilation and liquid-level instrumentation connections will be the same as for loading. Also, the waste water connection at the tank trailer will be the same as for loading. The unloading pump will be located on a platform lying above the LERF catch basin. For unloading operations, the waste water line from the tank trailer will be quick-connected to the inlet of an unloading pump (Figure 4-21). The discharge of the unloading pump will be piped to a second LERF Basin 43 riser in the LERF catch basin (Figure 4-20). The on/off controls for this pump will be located at the load/unload station.

4.3.3.2.3 Containment and Surveillance at the Liquid Effluent Retention Facility Load/Unload Station.

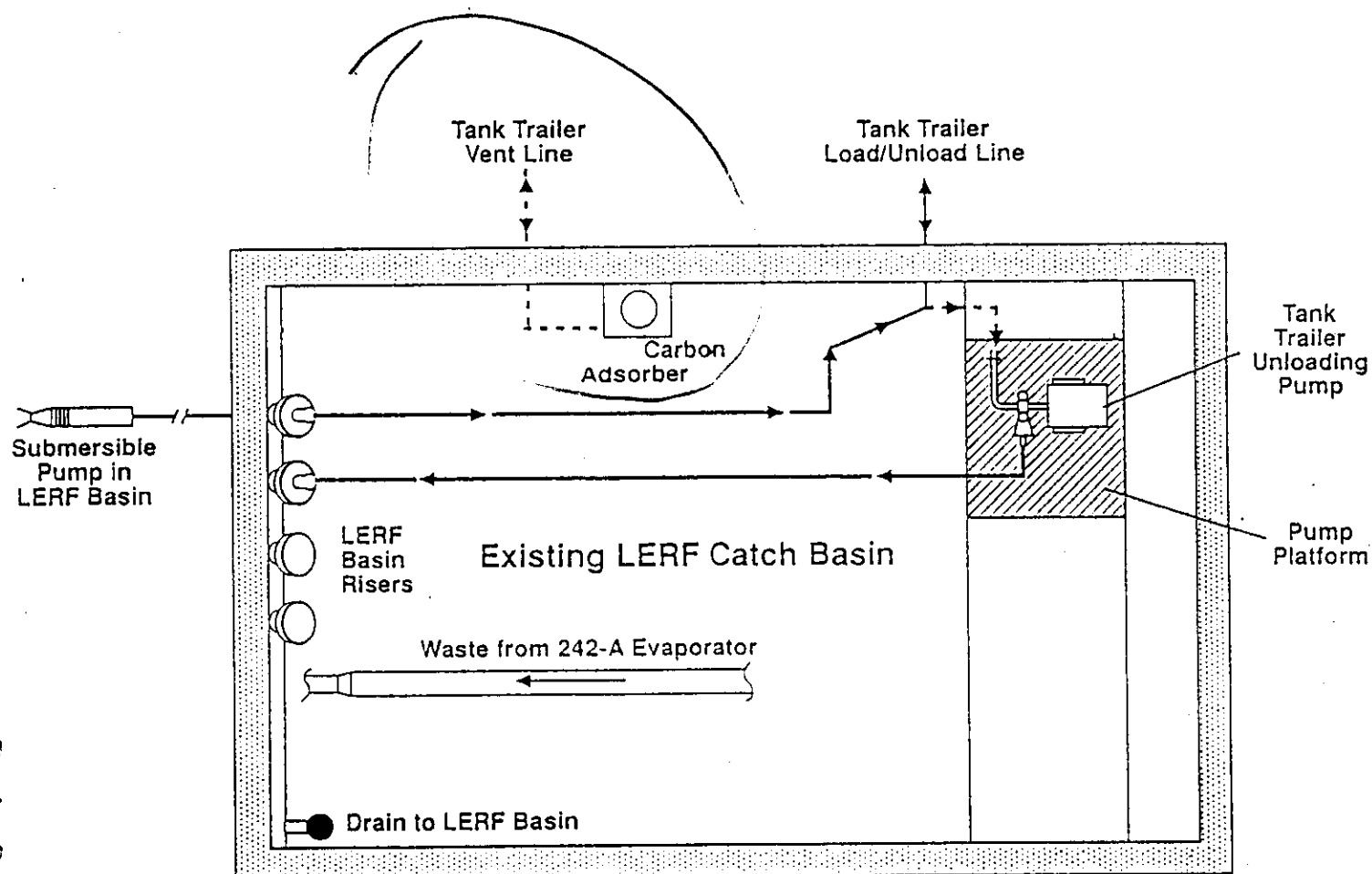
The piping from the flex hose to the LERF catch basin will be aboveground, all-welded, and hence does not require secondary containment. The LERF catch basin will provide secondary containment for the piping and the pump at the LERF basin (Figures 4-21 and 4-22). The LERF catch basin will have a drain leading back into the LERF 43 basin.

Secondary containment will be provided for the tank trailer, waste water load/unload flex hose, and connector through the use of a portable berm. The secondary containment structure selected for use is the SpilGard^a portable berm manufactured by ModuTank Inc. The portable berm is discussed in detail in Section 4.3.3.4. A custom-made SpilGard will be used at the LERF. This portable berm will be a single-wide unit that is 11 feet 9 inches (3.6 meters) wide, by 58 feet (17.7 meters) long, by 2 feet (0.6 meters) deep. The berm will have a single end gate through which the tractor trailer will be backed into the berm for loading or unloading. The length will allow the tractor to remain connected to the tank trailer during waste loading or unloading activities.

The portable berm unit at the LERF will have a capacity of 10,200 gallons (38,600 liters). The berm will have the capacity to contain the full contents of the 5,000 gallon (18,900 liter) tank trailer plus more than sufficient capacity to contain the 637 gallons (2,411 liter) that could result from a 25-year, 24-hour storm as required by WAC 173-303-630(7). The 25-year, 24-hour storm event is calculated to deliver 1.5 inches (3.8 centimeters) of

^aSpilGard is a trademark of ModuTank Inc.

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Figure 4-20. The Liquid Effluent Retention Facility Catch Basin Piping Configuration

1 8.1.14 Schedule for Closure
2

3 The waste water pilot plant is expected to operate for a period of
4 1 year. Depending on the progress of the test efforts, up to two additional
5 1-year operational periods could be requested. Any dangerous waste in the
6 pilot plant will be removed within 90 days following the completion of the
7 test program. All closure activities will be completed within 180 days
8 following the completion of the test program.
9

10
11 8.1.15 Amendments to Closure Plan
12

13 Should changes be required to the approved closure plan, an amended plan
14 will be prepared and submitted to the EPA and Ecology for approval in
15 accordance with 40 CFR 264.112(c) and WAC 173-303-610(3)(a).
16

17
18 8.1.16 Certification of Closure and Survey Plat
19

20 Within 60 days of the final closure of the waste water pilot plant, the
21 DOE-RL will submit a certification of closure to the EPA and Ecology in
22 accordance with 40 CFR 264.115 and .116 and WAC 173-303-610. This
23 certification will be signed by an authorized representative of the DOE-RL and
24 by an independent registered professional engineer, and will state that the
25 waste water pilot plant has been closed in accordance with the approved
26 closure plan. The certification will be submitted by registered mail or an
27 equivalent delivery service. The independent, registered professional
28 engineer, who will be monitoring closure, will visit the site at least at the
29 commencement and at the end of each activity described in the closure plan
30 (e.g., inventory removal, contaminated equipment removal, 1706-KE Building
31 decontamination). The professional engineer will review all records, notes,
32 analyses, files, manifests, etc., relating to the closure activities.
33 Documentation supporting the closure certification will be retained by the
34 DOE-RL and provided to the EPA and Ecology upon request. This documentation
35 will be kept by the DOE-RL contact (or its successor) identified in Section
36 8.3.
37

38
39 8.1.17 Owner/Operator Closure Certification
40

41 The DOE-RL will certify the closure of the waste water pilot plant with
42 the following statement or a statement similar to it:
43

44 "I, (name), an authorized representative of the U.S. Department of Energy
45 Richland Field Office, located at the Federal Building, 825 Jadwin
46 Avenue, Richland, Washington, hereby state and certify that the waste
47 water pilot plant to the best of my knowledge and belief, has been closed
48 in accordance with the attached approved closure plan, and that the
49 closure was completed on (date). (Signature and date.)"
50
51

1 8.1.18 Professional Engineer Closure Certification

2
3 The DOE-RL will engage an independent registered professional engineer to
4 certify that the waste water pilot plant has been closed in accordance with
5 this approved closure plan. The DOE-RL will require the engineer to sign the
6 following statement or a statement similar to it:

7
8 "I, (name), an independent registered professional engineer in the state
9 of (state name) hereby certify, to the best of my knowledge and belief,
10 that I have made visual inspection(s) of the waste water pilot plant and
11 that closure of the aforementioned facility has been performed in
12 accordance with the attached approved closure plan. (Signature, date,
13 state professional engineer license number, business address, and
14 telephone number.)"
15

16
17 8.3 CLOSURE COST ESTIMATE [I-4]

18
19 In accordance with 40 CFR 264.140(c) and WAC 173-303-620(1)(c), this
20 estimate is not required for federal facilities. The Hanford Facility is a
21 federally owned facility for which the federal government is the operator and
22 this estimate is therefore not applicable to the waste water pilot plant.
23

24 An annual report updating projections of anticipated closure and
25 postclosure costs for the Hanford Facility TSD units having final status will
26 be submitted in accordance with WAC 173-303-620(1)(c) to Ecology by
27 October 31.
28

29
30 8.4 FINANCIAL ASSURANCE MECHANISM FOR CLOSURE [I-5]

31
32 In accordance with 40 CFR 264.140(c) and WAC 173-303-620(1)(c), this
33 section is not required for federal facilities. The Hanford Facility is a
34 federally owned facility for which the federal government is the operator and
35 this section is therefore not applicable to the waste water pilot plant.
36

37
38 8.5 LIABILITY REQUIREMENTS [I-8]

39
40 In accordance with 40 CFR 264.140(c) and WAC 173-303-620(1)(c), this
41 section is not required for federal facilities. The Hanford Facility is a
42 federally owned facility for which the federal government is the operator and
43 this section is therefore not applicable to the waste water pilot plant.
44
45

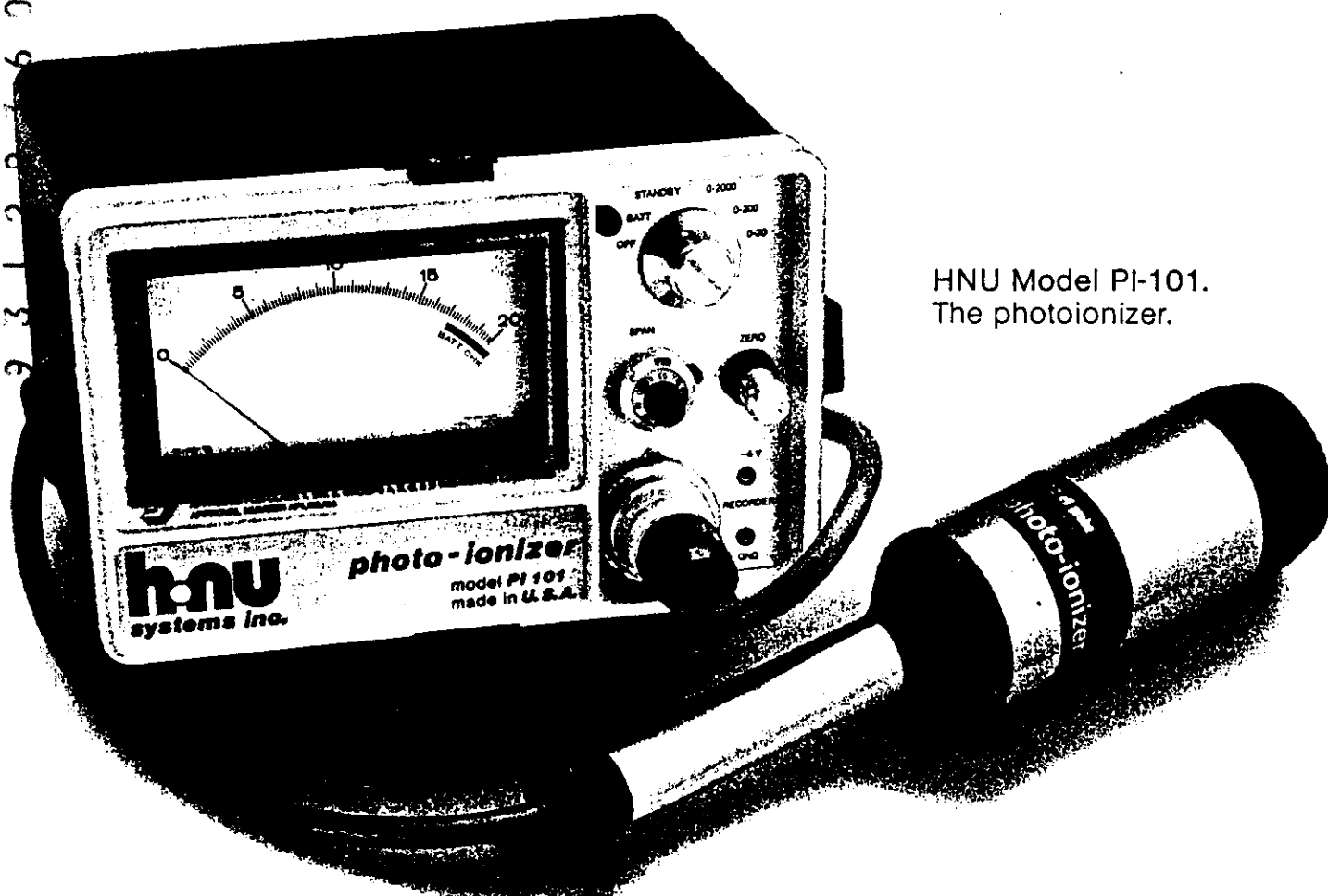
trace gas analysis by photoionization

hnu

HNU Systems, Inc., 160 Chailemont Street, Newton, Massachusetts, 02161-9987

chemical instrumentation

42909702136



HNU Model PI-101.
The photoionizer.



APPROVED FOR CLASS I, DIV. II, GROUPS A, B, C & D HAZARDOUS LOCATIONS
APPROVAL NUMBER APL/33/84

trace gas analyzer that can be used to measure a wide variety of organic vapors including chlorinated hydrocarbons, heterocyclics and aromatics, aldehydes and ketones as well as several inorganic gases including hydrogen sulfide and ammonia.

The instrument uses the principle of photoionization as the analytical technique and overcomes many of the problems inherent in current trace gas analysis instrumentation. These problems presently include poor limits of detection, slow and sluggish time response, background electronic noise or drift and a lengthy series of precise technical operations necessary to properly use the instrumentation. In addition, many of today's portable analyzers remain heavy, cumbersome instruments that require additional portable equipment such as sample pumps or compressed fuel and zero gases or bulky power packs for operation.

The advanced technology employed in the photo-ionizer successfully overcomes these disadvantages. For example, the limit of detection for most species is extended down to 0.1 ppm—an increase of 10–100 fold over many conventional instruments—while still maintaining a wide dynamic operating range (0.2 to 2000 ppm). This improved sensitivity allows industrial hygienists to make measurements at or below the TLV's (threshold limit values) established by OSHA.

Time response is greatly improved by several design advances. The location of the sensing chamber at the sampling point in the hand-held probe, the fabrication of all sample contact areas with inert fluorocarbon materials and a rapid sample flow through a small analyzing chamber eliminate sample hang up (adsorption) and minimize sample transit time in the instrument. The problems of delayed time response and instrument sluggishness are

full scale concentration change (0–2000 ppm) is less than five seconds—a significant feature when the instrument is used to locate plant "hot spots" or to detect leaks.

All solid state electronics and state-of-the-art circuit design have virtually eliminated conventional instrument drift and background noise. Zero drift is less than 1% over 10 hours. The excellent stability and drift free electronics allow accurate measurements, even at very low concentrations.

The Model PI 101 is one of the simplest analytical instruments to use since it has only three operating controls and unskilled personnel are easily and quickly trained to operate it. An easy to read 4½" linear scale provides a readout directly in units of concentration (ppm). Other features include an electronic zero that eliminates the use of a zero gas, and instrument calibrations that hold for weeks. The elimination of a flame, igniters and compressed hydrogen fuel make the photo-ionizer simpler to use than a flame ionization analyzer while providing an unusually safe instrument.

This lightweight (less than nine pounds) instrument was designed primarily as a portable analyzer for survey work and leak detection. However, the unit can also be set up as a continuous stationary monitor powered by 110V through its battery recharger/converter system. A strip chart recorder can be attached to the outputs (0–5V) provided.

Further details about the principle of operation and the significant technical advances this instrument provides are described in the following pages. Additional technical literature regarding your particular application and the photo-ionizer's response and sensitivity to the particular species of interest is available upon request.

Write, call, or use the attached postage paid reply card for further information.

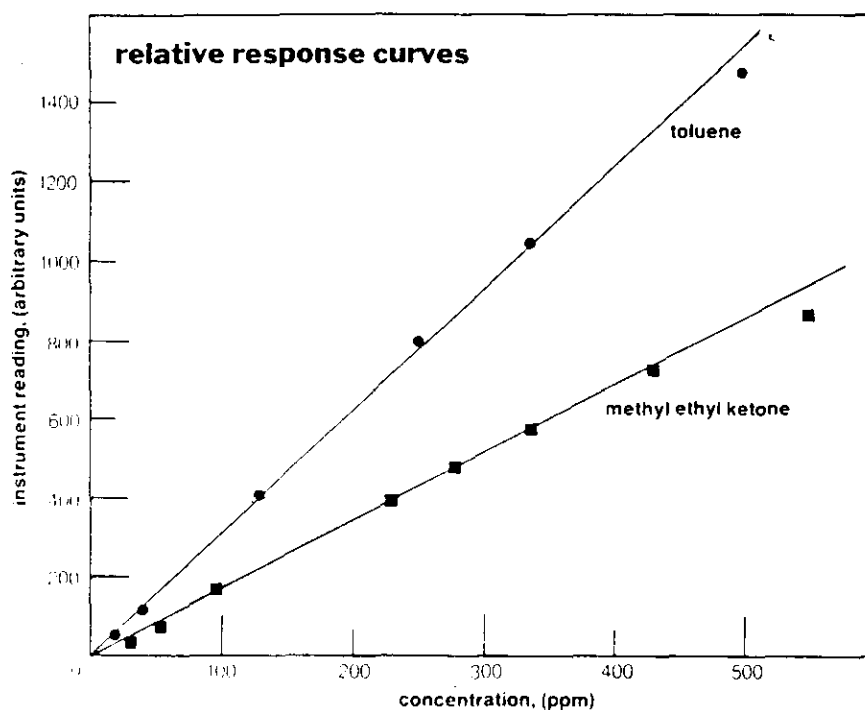
principle of operation

The photo-ionizer is a trace gas analyzer used to measure the concentration of a wide variety of species in industrial atmospheres. The analyzer employs the principle of photoionization for detection. The process is termed photoionization since the absorption of ultraviolet light by a molecule leads to ionization via: $R + h\nu \rightarrow R^+ + e^-$ where R^+ is the ionized species and $h\nu$ represents a photon which has an energy \geq the ionization potential of the species.

The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not

ionize the major components of air such as O_2 , N_2 , CO , CO_2 , or H_2O . A chamber adjacent to the ultraviolet source contains a pair of electrodes. When a positive potential is applied to one electrode the field created drives any ions formed by the absorption of UV light to the collector electrode where the current (proportional to the concentration) is measured. Typical calibration curves showing the relative response of toluene and methyl ethyl ketone (at the same gain setting) are shown below.

Information on the relative response factors for other species is available upon request.



the photo-ionizer — accurate measurements, easily obtained

sensitivity A maximum sensitivity of 0-2 ppm, full scale, can be obtained for many species. This scale is readable to 1% (100 division scale).

limits of detection Typical limits of detection are 0.2 ppm. In many cases these lower limits represent a 10-100 fold improvement over conventional portable analyzers.

operating range The linear range for most compounds is from 0.1 ppm to 600 ppm while the useful range typically extends to 2000 ppm.

stability Zero drift is extremely low, normally 1% or less over 10 hours, on battery operation. On AC operation, zero drift is less than 1% over 24 hours. Semiweekly span calibrations (100 ppm toluene) over a one month period give a relative standard deviation of $\pm 4.5\%$. This long term stability of both zero and span is due to the solid state electronics and stable ultraviolet light source.

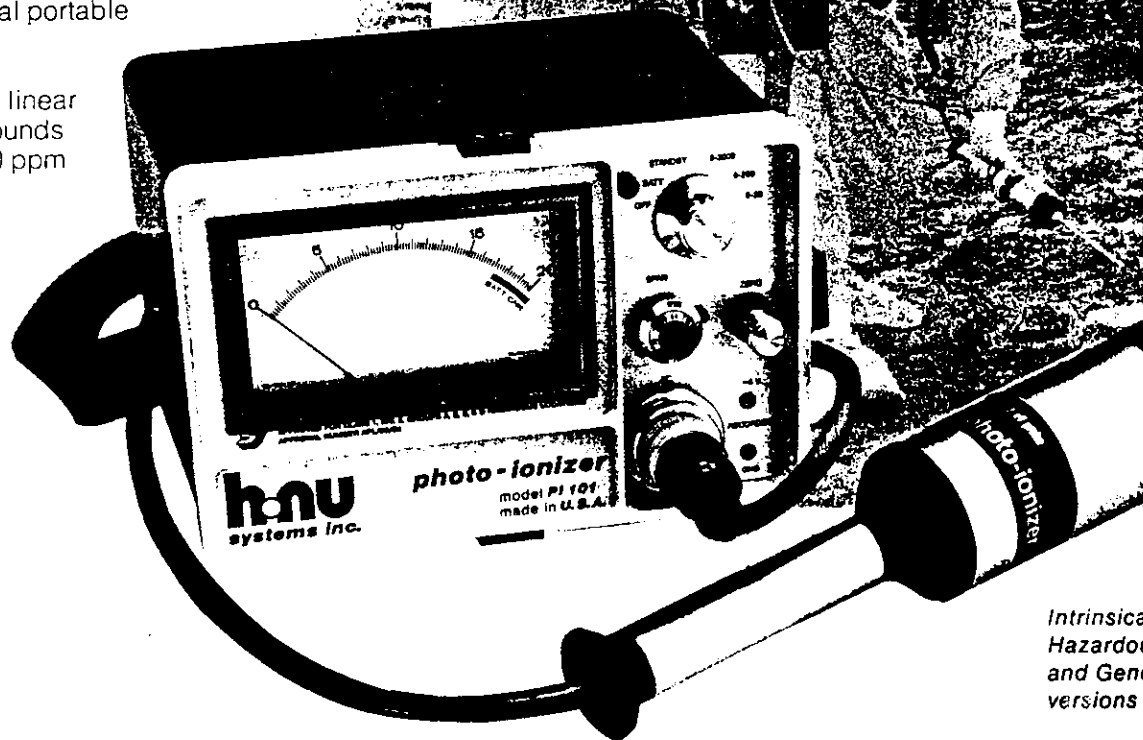
specificity Specificity in photoionization analysis depends on the sensitivity of the detector to the species being measured, the number of interfering species present, and the concentration of the species being measured relative to interferences. The optimum specificity can be obtained by choosing the light source (9.5 eV, 10.2 eV, 11.7 eV) to suit the application, maximizing sensitivity to the species being analyzed and minimizing any possible interference. Return the postcard for details on your application.

rapid response Response to changes in concentration is extremely rapid. A 90% of full scale change (0-2000 ppm) takes less than five seconds. In addition, the sensor is located at the sampling point rather than inside the instrument. This eliminates the problems of hydrocarbon adsorption and transit time through a sampling tube, all of which can delay the real time response by 30-45 seconds or more.

AC/DC operation — The instrument power is supplied from a 12 VDC rechargeable battery which gives a *minimum* of 10 operating hours before recharging is necessary. The AC recharger provides the option of operating the unit continuously from 110V AC so that the instrument can be used either as a portable unit for industrial hygiene surveys and leak detection work or as a continuous stationary monitor. An optional HNU Recorder can also be operated with the 101 battery.

The instrument is equipped with an automatic solid state battery protection circuit to prolong battery life by preventing deep discharging. Both the analyzer and the recorder can be operated during the recharge cycle.

portability The instrument is truly portable, with a total weight of less than 9 pounds (4.1 Kg) complete. No additional bulky power packs, sample pumps or cylinders of fuel gas or zero gas are needed. When not in use, the hand-held sensor is stored in the instrument cover and the total package measures 21 cm wide x 13 cm deep x 24 cm high.



Intrinsic
Hazardous
and General
versions

photo courtesy of Ecology and Environment

selected list of species detected

NR: no response
H: high response
L: low response

direct reading Concentration (ppm) is read out directly on an easy to read 4.5" (11.3 cm) linear scale.

three simple operating controls

Function and Range Switch This switch puts the instrument into the STANDBY, BATTERY CHECK, MEASUREMENT modes or OFF position. The MEASUREMENT position allows the choice of a 0-2 ppm, 0-20 ppm, 0-200 ppm or 0-2000 ppm full scale range. The STANDBY mode reduces power consumption between measurements. The BATTERY CHECK allows a manual power check before use while an LED (red indicator light) adjacent to the function switch provides an automatic battery check indicator during operation.

Zero Adjust The zero control allows electronic calibration of the instrument at the zero concentration point without requiring the use of a zero gas.

Span To calibrate the instrument for a particular gas, this control is adjusted to the gain setting which will match the value of a calibration gas to that same reading on the instrument scale. This control also provides the 10 fold increase in gain that allows the 0-2 ppm full scale range.

recorder outputs A signal output of 0-5V full scale is provided on the front panel for the attachment of a strip chart recorder.

electronic zero Zero calibration is done completely electronically. The instrument is switched to the STANDBY mode where the UV light source is turned off but the other electronics remain on. The zero control is adjusted until the meter indication is zero. No zero gas or regulators are needed; no further adjustments are required. Verification tests for this technique against hydrocarbon-free zero gas show perfect agreement.

safety The photo-ionizer is extremely safe to use, requiring no flames, igniters, or hydrogen fuel. Versions are available for use in General Purpose, Hazardous Waste; Class I, Division II and Class I, Division I, Group ABCD areas.

instant warmup Solid state electronics produce stable readings within 20 seconds after turning the instrument on.

class species	photoionization response		
	9.5 eV lamp	10.2 eV lamp	11.7 eV lamp
paraffins and unsaturated hydrocarbons			
methane	NR	NR	NR
ethylene	NR	L	H
acetylene	NR	NR	H
1-butene	H	H	H
hexane	NR	L	H
chlorinated hydrocarbons			
methyl chloride	NR	NR	H
carbon tetrachloride	NR	NR	H
chloroform	NR	NR	H
dichloroethane	NR	NR	H
vinylidene chloride	L	H	H
vinyl chloride	L	H	H
trichloroethylene	H	H	H
heterocyclics & aromatics			
phenol	H	H	H
pyridine	H	H	H
benzene	H	H	H
toluene	H	H	H
xylene	H	H	H
styrene	H	H	H
aniline	H	H	H
chlorobenzene	H	H	H
nitrobenzene	NR	L	H
nitrogen compounds			
formamide	NR	H	H
ammonia	NR	L	H
hydrazine	H	H	H
methyl amine	H	H	H
acetonitrile	NR	NR	NR
acrylonitrile	NR	NR	H
sulfur compounds			
sulfur dioxide	NR	NR	NR
hydrogen sulfide	NR	H	H
carbonyl sulfide	NR	NR	H
carbon disulfide	H	H	H
methyl mercaptan	H	H	H
dimethyl sulfide	H	H	H
dimethyl disulfide	H	H	H
aldehydes, ketones, alcohols, acids, esters			
formaldehyde	NR	NR	H
acetaldehyde	NR	H	H
propionaldehyde	L	H	H
acrolein	L	H	H
crotonaldehyde	L	H	H
acetone	L	H	H
methanol	NR	NR	H
ethanol	NR	L	H
formic acid	NR	NR	H
acetic acid	NR	L	H
methyl methacrylate	L	H	H
others			
ethylene dibromide	NR	H	H
ethylene oxide	NR	L	H
tetraethyl lead	H	H	H
phosphine	NR	H	H
arsine	NR	H	H
iodine	H	H	H

le (IS-101),
ste (HW-101),
urpose (GP-101)
available.

specifications

performance (benzene referred)

range 0.2 to 2000 ppm
detection limit 0.2 ppm
sensitivity (max) 0-2 ppm FSD over 100 division meter scale
repeatability $\pm 1\%$ of FSD
linear range 0.1 to 600 ppm
useful range 0.1 to 2000 ppm
response time < 5 sec to 90% of full scale

physical

size: probe 6.3 DIA x 28.5L (cm) (2½ x 11¼")
readout 21W x 13D x 16.5H (cm) (8¼ x 5¾ x 6½")
stowed 21W x 13D x 24H (cm) (8¼ x 5¾ x 9½")
cable 80 cm long (32")
weight probe .55kg (20 ounces)
readout 3.2kg (7 pounds)
total (shipping) 5.4 kg (12 pounds)

controls and functions

mode switch Off, Battery check, Standby (zero), 0-2000,
0-200, 0-20 ppm
low battery indicator light
zero (10 turn $\pm 300\%$ FSD max)
span (10 turn counting dial 1.0 to 10 times nominal sensitivity)
readout 4½" (11.3 cm) meter Taut Band movement
graduated 0-5-10-15-20, divisions
outputs recorder 0-5 VDC

power requirements of operating times

continuous use with battery > 10 hours
with HNU Recorder > 6 hours
recharge time, max < 14 hours, 3 hours to 90% of full charge
recharge current, max .4 amps @ 115 VAC

construction

Designed to withstand the shock and abuse to which portable instruments are often subjected.

The readout is housed in a two piece aluminum case, and finished with a solvent resistant baked acrylic textured paint.

The probe is fabricated from extruded aluminum sections and machined plastic.

serviceability

The probe and readout are of a modular design allowing rapid servicing and/or replacement of mechanical and electrical components. All module interwiring includes quick disconnects.

maintenance

The instrument contains only one moving part, and consumes no gases or reagents. The only routine maintenance procedure is cleaning the light source window every several weeks.

applications

industrial hygiene surveys of toxic gases for OSHA (TLV) compliance can be rapidly accomplished with this portable, direct reading instrument. Hood ventilation rates can also be measured accurately because of the sensitivity and wide operating range of the unit.

leak detection is facilitated by the rapid instrument response and extreme sensitivity. This enables the user to locate even small leaks very rapidly.

residual solvent vapors such as trichloroethylene in decaffeinated coffee or degreasing operations, hexane from soybean extraction and other vapors from **food, chemical processing, paint spraying** or coating can be easily and rapidly measured.

benzene concentrations as low as .1 ppm can be selectively measured using a 9.5 eV lamp. This lamp eliminates most common interferences.

non methane hydrocarbons in the atmosphere can be **measured directly** since the photo-ionizer does not respond to methane.

vinyl chloride measurements in monomer plants can be made without interference from major starting materials or by-products such as ethylene and ethylene dichloride (dichloroethane). Low level vinyl chloride measurements in PVC fabrication processes do not have the 1-2 ppm methane background interference seen in other portable instruments.

For additional information on specific applications, please fill out the attached postage-paid reply card or call us at (617)964-6690. To place an order, call us toll-free at (800)527-4566.

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Volatile Organic Concentration in Tank Trailer Ventilation Air at the Liquid Effluent Retention Facility Load/Unload Station

Purpose

The purpose of this analysis is to estimate the volatile organic compound (VOC) concentration in the air vented during the filling of the tank trailer at the LERF load/unload station.

Assumptions

- 1) The VOC concentrations used in this analysis are the 90 percent confidence interval values reported in Table 4-2.
- 2) The average molecular weight of the VOC is 73. This is a weighted average value based on the molecular weights of acetone (58) and 1-butanol (74). These two compounds contribute 97 weight percent of the VOC in the wastewater. (Table 4-2, "90 percent confidence values).
- 3) 1 weight percent of the VOC are volatilized into the trailer ventilation air stream.
- 4) One gallon of tank trailer air is vented for every gallon of wastewater pumped into the tank trailer.
- 5) Maximum VOC loading in the wastewater is 12.4 parts per million (ppm), or 0.517 pounds (lbs) VOC per 5,000 gallons (gal).
- 6) The temperature is 70 degrees Fahrenheit (°F) [529 degrees Rankine (°R)].

Calculation

$$\begin{aligned}\text{VOC (ppm)} &= 0.01 \times (0.517 \text{ lb VOC}/5,000 \text{ gal}) \times (7.48 \text{ gal}/\text{ft}^3) \times \\ &\quad (529 \text{ }^\circ\text{R}/491 \text{ }^\circ\text{R}) \times (1 \text{ lb-mole VOC}/73 \text{ lb VOC}) \times \\ &\quad (359 \text{ std ft}^3/\text{lb-mole}) \times 1,000,000 \\ &= 41.0 \text{ ppm}\end{aligned}$$

Conclusions

The "maximum" feed case, the VOC concentration in the tank trailer exhaust air (feed to the carbon adsorber) will be approximately 40 ppm.

Analysis prepared by:

D. E. Scully
Effluent Process Engineering
Westinghouse Hanford Company
November 11, 1992

Volatile Organic Concentrations in the Inlet to
the 1706-KE Building Ventilation System Charcoal Filter
Using "Spike" Concentrations

Purpose

The purpose of this analysis is to calculate the expected inlet concentrations to the 1706-KE Building charcoal system so that the expected breakthrough concentration setpoint for the volatile organic chemicals (VOC) analyzer can be determined.

Assumptions

- 1) The charcoal system is on the ventilation branch for the tank vents. The tanks vented include: tanker trucks (2), intermediate storage tanks (2), surge tanks (2) and filtrate tank.
- 2) Liquid treatment feed rate: 5 gallons per minute (nominal)
- 3) Vent flow rate: 50 cubic feet per minute (cfm) (rating for TIGG Model N50 at 7 inches H₂O)
- 4) The average molecular weight of the five most prominent compounds in Table 4-3 is 67.5. These five compounds (1-butanol, acetone, pyridine, carbon disulfide, and formic acid) make up 92 percent of the volatile organics present in the spiked feed.
- 5) Feed concentration: 2.989 pounds (lb) VOC per 1,000 gallons (gal). This is the maximum concentration as stated in Table 4-3.

Calculations

Assuming 100 percent volatilization of the max concentrations and temperature of 20 °C:

$$\left(5 \frac{\text{gal}}{\text{minute}}\right) \left(\frac{2.989 \text{ lb VOC}}{1,000 \text{ gal}}\right) \left(\frac{1 \text{ lb-mole}}{67.5 \text{ lb VOC}}\right) \left(359 \frac{\text{ft}^3}{\text{lb-mole}}\right) \left(\frac{293 \text{ }^\circ\text{C}}{273 \text{ }^\circ\text{C}}\right) =$$
$$(0.08531 \frac{\text{ft}^3 \text{ VOC}}{\text{min}})$$

$$\frac{(0.08531 \text{ cfm VOC}) (1,000,000)}{50 \text{ cfm total}} = 1,706 \text{ parts per million VOC}$$

Therefore, if only 10 percent of the volatile organic compounds are volatilized, then the VOC concentration to the charcoal would be 171 parts per million. Likewise, if only 1 percent volatilization occurs, then the inlet concentration would be 17 parts per million.

Conclusions

Because the pilot plant is designed to minimize the volatilization of feed compounds, the value of 1 percent of the maximum concentrations is realistic. The recommended VOC analyzer control point should be 10 parts per million. This will be low enough to detect breakthrough, but should be high enough to prevent false alarms.

Analysis prepared by:

R. S. Pavlina
Chemical Engineering Laboratory
Westinghouse Hanford Company
November 12, 1992

9 3 1 2 9 3 6 0 6 3 5

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